

Fun With Science (FWS)

Responsible Individual (RI): Dick Farnsworth (Ext. 2-5059)

Alternate Responsible Individual: Don L. Correll (Ext. 2-6784)

Location(s): B415, T4107, & various offsite locations

1.0 Reason for Issue

Fun With Science is a science activity taken off-site into schools and to children's organizations, and presented to visitors to LLNL in white areas on site. Experiments are performed in front of and with the help of students. This Operational Safety Plan (OSP) and a review of the experiments with Hazards Control staff provide the safety assessment and control implementation to minimize unnecessary risks to persons attending the presentation. Per the LLNL *Environment, Safety, and Health (ES&H) Manual*, offsite work requires an OSP.

2.0 Responsibilities

- 2.1 Dick Farnsworth (Ext. 2-5059) is responsible for ensuring the safety of this operation and for ensuring that all work is performed in conformance with this OSP and applicable sections of the *ES&H Manual*. In the absence of Dick Farnsworth, Don Correll (Ext. 2-6784) shall assume these responsibilities. URP-STEP is the Authorizing Organization and is responsible for managing the covered work activities.
- 2.2 Offsite locations include school, career fairs and public demonstrations. At all offsite locations, a person from the offsite location shall be in attendance and maintain responsibility for the children during all aspects of the Fun With Science program. In the classroom this will be a teacher from the school. At other public demonstrations this will be an official or representative of the organization hosting the meeting.
- 2.3 The presenter is responsible for following the requirements of this OSP and its attachments during all phases of the Fun With Science operation. The presenter must stop all activity when an unsafe condition or unsafe act presents itself during the course of the demonstrations. The presenter must ensure that a contact is available during the entire Fun With Science program. The contact at a school is a teacher or employee of the school. At other gatherings the contact is an official or employee of the organization hosting the event. If the offsite contact must leave the area, the presenter shall stop all operations until the local contact returns to the area of the demonstration. The presenter is responsible for maintaining control of all equipment while visiting an offsite activity and shall not allow children to assist with moving the equipment at any time. The presenter must ensure that an adult is present in the room at all times where LLNL equipment is located unless the room is secured from entry by unauthorized personnel.

2.4 Controlling Changes to Operations or Equipment

Any modifications to the operations covered by this OSP that may increase or change a risk or hazard beyond those commonly accepted by the public must be analyzed and documented in an update of the IWS that relates to this OSP.

The responsible individual shall ensure that any changes in operations that increase the level of hazard, introduce additional hazards, or decrease safety shall not be made until a revision of or supplement to the IWS and this OSP have been reviewed and approved. The review and approval process must be consistent with the process for the original IWS and OSP.

3.0 **Scope of Work**

The Fun With Science program provides young people with an entertaining demonstration of applied science. Its purpose is to entertain while demonstrating that science can be interesting. To reach that goal, the program demonstrates basic concepts of physics with an emphasis on the relationship between science and their everyday life.

3.1 Work to be Done:

Science demonstrations presented to students cover a range of several topics including:

- Pressure
- Use of Liquid Nitrogen and cryogenic temperatures
- Light and Laser
- Electricity & magnetism
- Chemistry

See attached Appendix C "Demo Descriptions" describing in detail all the experiments.

3.2 Location of the Activity:

Preparation work is done in T4107.

Upon request from schools and children's organizations in Northern California and Nevada, primarily in the following counties: Alameda, Contra Costa, San Joaquin, Stanislaus, and Santa Clara.

4.0 Hazards Analyses and Controls

4.1 Preparation Activities:

Hazards

- Handling/mixing chemical solutions and possible skin or eye contact with chemicals
- Spilling liquid nitrogen
- Loading equipment into van
- Handling gas cylinders

NOTE: The Facility Point of Contact (FPOC) usually prepares the materials and places them into the vans for the daily planned activity.

The following controls correspond, in order, to the above mentioned hazards.

Controls

- 4.1.1 Storage, handling, use, and labeling of chemicals shall be in accordance with Document 14.1, "Chemicals" in the *ES&H Manual*. At a minimum, appropriate protective gloves, safety glasses, and a lab coat or apron shall be worn when mixing chemicals. A face shield shall be added when there is potential for chemical splash.
- 4.1.2 Persons purchasing hazardous materials will follow the guidance in Document 21.1, "Acquisition, Receipt, Transportation and Tracking of Hazardous Materials;" Document 14.1, "Chemicals;" and Document 35.1, "Product Storage/Hazardous Materials" in the *ES&H Manual* to ensure the materials are entered into the LLNL ChemTrack System.
- 4.1.3 Hazardous waste may be generated from the proposed mixing of chemicals. Outdated and unused chemicals and materials which may be used to cleanup spills need to be evaluated to determine proper disposal. For assistance in determining if a hazardous waste is generated and for managing such waste correctly, contact your Environmental Analyst or your Hazardous Waste Management Division Field Technician.
- 4.1.4 Storage and handling of liquid nitrogen (LN) shall be in accordance with Document 18.5, "Cryogenics" in the *ES&H Manual*. Only the minimum quantity of LN required for the day will be transported. Loose-fitting gloves, such as leather, and safety glasses shall be worn while handling LN. A face shield shall be added when LN is poured, transferred, or if fluid in a container is likely to bubble. The dewars fit into the wooden cases provided for transport. The Facility Point of Contact will secure the latches of the wooden case to minimize spilling in case of accident.
- 4.1.5 Hand carts will be used to transport materials and equipment to the Fun With Science van. All materials and equipment will be placed into proper

storage devices when placed into the van to ensure secure storage within the vehicle during transport.

- 4.1.6 The FPOC will ensure all gas cylinders are covered with a standard cap when not in use. The regulators will be removed and caps placed on the cylinder prior to transporting. The gas cylinders shall be stored in the vehicle lying down in the specially designed wooden case. The FPOC will ensure that wooden case latches are secured.

4.2 Transportation:

Hazards

- General exposure from traffic related accidents
- Asphyxiation from LN spill
- Unstable material shifting from improperly stored equipment

The following controls correspond, in order, to the above mentioned hazards.

Controls

- 4.2.1 The LLNL presenter shall leave a van window ajar when transporting LN in dewars. Van windows must remain opened or cracked to prevent any possibility of asphyxiation during transport. The RI shall post a sign in the van warning the van driver to leave the window ajar (see Appendix B).
- 4.2.2 The van will transport no more than four dewars with a maximum capacity of 4 liters each. The dewars will be placed into the wooden cases provided for transport.
- 4.2.3 All materials shall be safely secured in the van before driving the van to ensure that equipment does not inadvertently roll around or shift creating unnecessary exposures to the driver during transport.
- 4.2.4 Gas cylinders will be covered with a standard cap when not in use. The regulators will be removed and caps placed on the cylinder prior to transporting. During transportation, gas tanks shall be stored lying down in the specially designed wooden case. Wooden case latches shall be secured.
- 4.2.5 Drivers shall follow the CA Motor Vehicle requirements during all offsite travel. Accidents shall be reported to the Responsible Individual as soon as reasonably possible. The Responsible Individual for this OSP shall notify ES&H Team 4 immediately upon learning about any incident.

4.3 General – (Presentation):

Hazards

- General exposure from chemicals, liquid nitrogen, compressed gases
- Injury exposure to underage children who wish to be helpful moving items or are curious about the material or equipment used in the presentations.
- Lifting heavy objects, transporting materials or equipment into offsite facilities.
- General injury exposure to minors.

Note: *Specific presentation hazards and controls are listed in Appendix C for each demonstration.*

The following controls correspond in order to the above mentioned hazards.

Controls

- 4.3.1 The LLNL presenter shall wear latex or nitrile gloves, safety glasses, and lab coat. A door or window should be opened when air-displacing gases or chemicals are used. No student should be in the immediate vicinity of the demonstration. Ample quantity of disposable wiping cloths or towels shall be available to wipe up spilling.
- 4.3.2 LN dewars should be placed on the floor of the area where the presentation will take place. The cover shall be on the dewar when not in use. Loose-fitting gloves such as leather, and safety glasses shall be required for presenter and student. Full-face shields shall be used, in addition to safety glasses, when pouring LN and when inserting or removing objects from LN.
- 4.3.3 At schools, an offsite facility representative will be in the room whenever LLNL material is accessible to the facility audience to ensure that underage children do not tamper or play with the LLNL equipment.
- 4.3.4 At career fairs, an LLNL representative must stay with the equipment or arrange for a responsible adult to stay with the equipment at all times, unless the equipment can be secured to eliminate public tampering or horseplay.
- 4.3.5 MSDSs for all chemicals, compressed gases, and liquid nitrogen shall be available during the experiments.
- 4.3.6 Carts shall be used to move equipment to and from the presentation facility. An adult associated with the school must be in the area when minor children are present with LLNL equipment.
- 4.3.7 A facility representative shall be in the area where minor children are actively watching the presentation in order to provide corrective action when children do not follow the directions of the volunteer presenter.

- 4.3.8 In case of an emergency, a school representative maintains responsibility for using the emergency response system of the facility. In the event of an earthquake, the presenter shall ensure that the chemicals do not pose a hazard to minors who are watching the presentation.
- 4.3.9 The presenter is responsible for warning the audience about the various exposures associated with each experiment and ensuring that proper precautions are taken prior to conducting an experiment. Each experiment has a detailed instruction sheet including the hazards, controls, and instructions for conducting the experiment. These are located in each experiment's equipment box.
- 4.3.10 The presenter is responsible for discussing safety measures associated with each experiment with audience, setting an example by wearing all safety equipment including glasses, face shields, gloves, lab coats, hearing protection and ensuring that the audience is not exposed to unnecessary risks during any of the demonstrations. The presenters represent LLNL and are expected to demonstrate the high ES&H standards set forth by the Laboratory whenever these presentations are given.

5.0 Training and Required Reading

- 5.1 The Fun With Science Program is responsible for ensuring that all presenters have sufficient on-the-job training prior to sending volunteers offsite alone. Volunteers must complete the following ES&H training courses, accompany an experienced presenter on at least 3 presentations, and must be accompanied on 3 presentations made prior to going to an offsite function alone.
- 5.2 All operating and user personnel shall satisfactorily complete the following classes:
 - a. As of CY 2001, each presenter participated in a FWS basic training session on either July 22, 1999 or August 11, 1999 that covered safety guidelines related to the program that shall be implemented. Courses will be provided in the future as needed.
 - b. Each new potential presenter is required to:
 - Attend a general FWS basic training session. This session highlights the hazards and controls for each of the Fun With Science demonstrations.
 - Participate several times (no less than 3), as an assistant to an experienced presenter.
 - Be accompanied no less than 3 times by an experienced presenter prior to conducting a FWS activity alone.
 - At no time will a presenter show experiments for which they have not been adequately trained and supervised to conduct.

5.3 The following classes are recommended:

HS-4050-W	"Health Hazards Communication for Supervisors"
HS-4240-CBT	"Chemical Safety"
HS-4360-CBT	"Noise"
HS-5030-W	"Pressure Safety Orientation"
HS-1670-CBT	"Qualification for Fire Extinguishers Users"
HS-5220-W"	"Electrical Hazards Awareness"
HS-5200	"Laser Safety"

5.4 Dick Farnsworth (Ext. 2-5059) is responsible for ensuring FWS presenters have completed the required training and for maintaining training records for FWS personnel as it pertains to this OSP.

6.0 Maintenance, Inspections, and Quality Assurance

Fun With Science equipment shall be inspected semi-annually and documented. The Responsible Individual shall ensure that the vehicle, activity specific equipment, and onsite location are in proper working order prior to each presentation. The presenter is responsible for providing feedback on any equipment issues to the Responsible Individual upon return to the site. The Responsible Individual shall perform an undocumented inspection of equipment prior to removing it from LLNL for offsite activities.

The Responsible Individual is responsible for all maintenance of equipment and vehicles used for the Fun With Science presentations. Any items that require routine maintenance will have the maintenance completed prior to the next scheduled activity or remove and tag it from service.

7.0 Emergency Response Plans and Procedures

Emergency response procedures for this operation shall follow those outlined in Document 22.1, "Emergency Management" in the *ES&H Manual*.

Presenters shall establish an emergency response contact at the offsite facility upon arrival. A person who is familiar with emergency procedures for the children in attendance should be identified by the Responsible Individual at the time the Fun With Science presentation is scheduled. If a child becomes injured as a result of presentation activities, the offsite facility contact will be responsible for following the offsite facility protocols for emergency response and family contact. The presenter should remain available to respond to any Fun With Science activity-specific issues. The presenter shall not be responsible for any emergency response of minors at offsite locations.

8.0 References

- LLNL *Environment, Safety, and Health Manual*

9.0 Review and Approval

This OSP was reviewed by:

Richard J. Farnsworth, Responsible Individual

Date

This OSP was concurred by:

Corrine D. Burgin, Team Leader, ES&H Team 4

Date

This OSP is approved by:

Jeffrey Wadsworth, Deputy Director,
Science and Technology

Date

Controlled Distribution List:

Burgin, C.	L-508
Correll, D.	L-428
Farnsworth, R. (3)	L-428
Gallegos, B.	L-508
Wadsworth, J.	L-001
ES&H Team 4 (5)	L-508
Emergency Management Division	L-388

SAFETY PLAN REVIEW FORM

All individuals listed below affirm that they have read and agree to comply with the attached safety plan.

[illegible]

After each review, a copy of this completed form should be sent to the Authorizing Organization's Assurance Office.

APPENDIX B

Important Safety Issues

To: Fun With Science Presenters
From: Fun With Science
Re: Transportation of Liquid Nitrogen



- Have a window opened a few inches when transporting Liquid Nitrogen Dewars.
- Ensure the latch is secured on the wooden box containing the Dewars.

APPENDIX C

DEMO DESCRIPTIONS

LIST OF DEMONSTRATIONS	
Chemistry #1	Slime
Chemistry #2	Elephant Toothpaste
Chemistry #3	Electrolysis of Water
Elasticity	Balloon and Skewer
Electricity #1	Van de Graff Generator
Electricity #2	Tesla Coil
Laser	Laser and Sound
LN #1	Glove Shattering
LN #2	CO ₂ Balloon and Dry Ice
LN #3	LN and Change of State
LN #4	Copper Bowl
Magnetism	Superconductor
Pressure #1	CO ₂ and He Balloons
Pressure #2	Airlift
Pressure #3	Marshmallows
Pressure #4	Metal Can-Air Out
Pressure #5	Metal Can-Pressure In
Pressure #6	Pressure Plates
Pressure #7	Hovercraft

Slime

Equipment or Chemicals:			
• Polyvinyl Alcohol (PVA)	• Sodium Borate (SB)	• Food-coloring	• Plastic glasses
• Plastic tray	• Kimwipes	• Wooden Stirrers	• Plastic zip lock bags

Hazards:	Controls:
• Spilling of chemicals.	<ul style="list-style-type: none">• Presenter shall use gloves, safety glasses, and lab coat when dispensing chemicals.• Use a photo tray for secondary containment.• MSDS for chemicals readily available.• Ample distance from students shall be maintained.• Ample quantity of Kimwipes shall be available to contain spilling.
• Ingestion of slime.	<ul style="list-style-type: none">• After experiment, slime shall be contained in a labeled zip-lock plastic bag and given to the teacher who will ensure proper disposal of the nonhazardous material.• Facility adult representatives will ensure children do not ingest slime.

Procedure:
<ul style="list-style-type: none">• Don gloves, safety glasses, and lab coat before dispensing chemicals.• Get 5 student helpers and give safety glasses to wear.• Fill a quarter of each student's glass with PVA.• Add a drop or 2 of food coloring to glass.• Add 20ml of SB to each glass and ask student to stir.• Observe change of consistency.

Elephant Toothpaste

Equipment or Chemicals:			
• Glass graduated cylinder	• H ₂ O ₂ 30 %	• KI 10%	• Whiteboard cleaner
• Plastic tray			

Hazards:	Controls:
• H ₂ O ₂ is corrosive and KI is an irritant.	• No student shall be within 3 feet from the experiment.
• Spill of chemicals.	• Gloves, safety glasses, and lab coat shall be worn by presenter. • Use a photo tray for secondary containment. • MSDS for chemicals readily available. • Ample distance from students shall be maintained. • Ample quantity of Kimwipes shall be available to contain spilling.
• Projection of chemicals.	• Cylinder shall be set in the tray on a table.
• Shattering of cylinder for temperature change.	• Cylinder shall be made out of Pyrex (2000 ml) and replaced every 12 months.

Procedure:
• Don safety gloves, safety glasses, and lab coat. • Ensure audience is located a safe distance prior to pouring chemicals. • Pour 50 ml of H ₂ O ₂ into a graduated cylinder. • Add 10 ml of KI to H ₂ O ₂ . • Add some liquid soap and observe.

Electrolysis of Water

Equipment or Chemicals:			
Sodium sulfate solution (Na ₂ SO ₄)	• Platinum wires	• Plastic electrolysis tank	• 9 Volt Battery
• Tesla coil	• Plastic tray	• Kimwipes	14" balloon

Hazards:	Controls:
• Exposure to Na ₂ SO ₄ may be irritating.	• Shall wear gloves, safety glasses, and lab coat. • Use a photo tray for secondary containment. • MSDS for chemicals readily available.
• Spilling of Na ₂ SO ₄ .	• Shall not fill the tank to the top. • Shall have Kimwipes for clean-up.
• Loud noise from balloon burst.	• Should warn the audience about loud noise. • Should open a door or window. • Balloon burst should be done in safe location, where no objects will be affected. • Presenter may wish to wear hearing protection as a means of demonstrating good safety practice.

Procedure:
<ul style="list-style-type: none"> • Don safety gloves, safety glasses, and lab coat. Place equipment inside photo tray for secondary containment. Ensure Kimwipes are nearby for spillage cleanup. • Fill up the Electrolysis tank sitting in the tray with the Na₂SO₄ solution. • Plug the battery to the 2 wires connected to the anode and cathode power terminals protruding out of the container. This will disassociate the water. • Fit a 14-inch balloon on top of tank. • Observe the balloon filling as it stretches over the opening and fills with hydrogen and oxygen. Warn the audience of possible loud noise during this demonstration. Never fill balloon to more than a standing position. Do not allow balloon to expand. • Grab the balloon at the base by pinching it and tie it off to contain the gas mixture inside the balloon. • Place the balloon between the 2 screws in the wooden stand. Warn audience that they may wish to cover their ears.

- Ensure adequate distance (6 feet) from the audience and place the tip of the Tesla coil on the screws that the balloon sits between.
- After the balloon has popped, talk to the class about what they heard, saw and smelled. Pass the balloon around to show students the results.

Balloon and Skewer

Equipment or Chemicals:			
• 9-inch balloon	• Wooden skewer		

Hazards:	Controls:
• Risk of stabbing with the skewer.	• Shall warn the student to point the skewer away from their hand.

Procedure:
<ul style="list-style-type: none">• Blow some air in the balloon.• Warn students that this is a noisy demonstration and they may wish to cover their ears.• Pierce the balloon with the skewer by pointing at nipple.• Ask a student to do the same with a different balloon.• Give student a skewer and remind them to point the skewer away from their hand.

Van de Graff Generator

Equipment or Chemicals:			
• VDG	• Stool	• Discharger	

Hazards:	Controls:
<ul style="list-style-type: none">Risk of electrical shock.	<ul style="list-style-type: none">Student shall be informed of the procedure before starting the demonstration.Student shall step on stool during demo.Student shall discharge her/himself by touching the wooden box after demo.Sphere shall be discharged after each charge.
<ul style="list-style-type: none">Fall from stool	<ul style="list-style-type: none">Ensure student is stable and comfortable prior to starting demo. Hold steady until comfortable. Explain the demo will not hurt.

Procedure:
<ul style="list-style-type: none">Explain about electrostatics while placing stool next to VDG. Place wooden box next to equipment setup.Turn the VDG on and observe the cork balls being repulsed from the sphere.Discharge the VDG.Have a student with long hair stand on the stool and put one hand on the sphere while fluffing her/his hair with the other hand during experiment.Instruct and have student discharge static by touching wooden box at the end of the demo.Discharge VDG sphere.

Tesla Coil

Equipment or Chemicals:			
• Tesla coil	• Copper tube	• Neon bulb	• Rubber tube

Hazards:	Controls:
<ul style="list-style-type: none">Electrical shock.	<ul style="list-style-type: none">Audience shall be warned of the hazards of electricity in general, especially in their environment (i.e. 110V outlets).Audience shall be informed about the difference between a 110 V outlet and a Tesla coil.Students shall not be in contact with any metal surface.Do not place Tesla coil between legs at any time.

Procedure:
<ul style="list-style-type: none">Discuss the hazards of electricity in general, especially in their environment (i.e. 110 outlets) and inform the audience of the difference between 110V and a Tesla coil.Ask 3 students for help and have them form a chain by holding hands. Remind them not to contact any metal surface during this demonstration.Ask the last student to hold the bulb by the glass.Ask the 1st student to hold the rubber tube.Touch the rubber tube with tip of Tesla coil and observe.Replace the rubber tube with the copper tube and repeat the experiment.

Laser and Sound

Equipment or Chemicals:			
• Laser Beam Class II 1.0 MW HeNe laser	• Fiber optics	• Sound receiver	• Microphone

Hazards:	Controls:
<ul style="list-style-type: none">• Eye injury.	<ul style="list-style-type: none">• Should warn the students about the hazards involved with laser beams in general.• Shall set the laser so that the beam path goes away from students.• Beam path will not be on the same level as the eyes of the audience and will be directed above or well below the eye position.• Do not use mirrors and show minors how to direct the beam.• Ensure the beam does not hit a surface that will cause reflections or deflection.• Ensure audience does not peer into the fiber optic ends at any time.

Procedure:
<ul style="list-style-type: none">• Set the alignment of the laser beam and receiver.• Plug the microphone into the receiver.• Use the fiber optics. Discuss the hazard of looking into a fiber optic.

Glove Shattering

Equipment or Chemicals:			
• Dewar	• Leather gloves	• Liquid Nitrogen (LN)	

Hazards:	Controls:
• Direct contact with LN.	<ul style="list-style-type: none">• Loose-fitting gloves (such as leather) and safety glasses shall be required for presenter and student. Full-face shields shall be used, in addition to safety glasses, when pouring LN and when inserting or removing objects from LN.• Do not use hand, even if gloved, to push an object into LN. Use wooden tongs, stir stick, spoon, or similar instrument to insert or remove objects from LN.
• Spilling of LN on the floor.	<ul style="list-style-type: none">• Glove shall be crushed above trashcan.• A door or window in the classroom shall be open when LN is in use.

Procedure:
<ul style="list-style-type: none">• Don leather gloves, safety glasses, and face shield.• Pour some LN into a dewar.• Drop extra glove in LN and take it out of it after 1 or 2 minutes.• Choose student volunteer and provide safety glasses and gloves.• Tell student to crush the frozen glove between his/her hands in front of the audience.

CO₂ Balloon and Dry Ice

Equipment or Chemicals:			
• Liquid nitrogen	• Dewar	• Long balloon	• CO ₂ gas tank

Hazards:	Controls:
• Direct contact with LN.	<ul style="list-style-type: none">• Loose-fitting gloves (such as leather) and safety glasses shall be required for presenter and student. Full-face shields shall be used, in addition to safety glasses, when pouring LN and when inserting or removing objects from LN.• Do not use hand, even if gloved, to push an object into LN. Use wooden tongs, stir stick, spoon, or similar instrument to insert or remove objects from LN.
• Projection of CO ₂ from tank.	<ul style="list-style-type: none">• Gas tank nozzle shall be directed away from student.
• Strong noise from possibility of balloon burst.	<ul style="list-style-type: none">• Audience should be warned about potential noise of balloon burst.• Door or window shall be opened prior to starting experiment.• Presenter should wear hearing protection as a means of demonstrating good safety practice.

Procedure:
<ul style="list-style-type: none">• Don safety glasses, face shield and gloves.• Fill the balloon with CO₂ gas.• Fill container with approximately 1 inch of LN.• Ask for a student volunteer, then provide them with safety glasses, face shield, gloves and a lab coat.• Ask a student to use the tongs to place the balloon in the LN and to show it again after scooping it out of the LN.

LN and Change of State

Equipment or Chemicals:			
• LN	• Adapter	• Flask	• 14 inch Balloon

Hazards:	Controls:
• Direct contact with LN.	<ul style="list-style-type: none">Loose-fitting gloves (such as leather) and safety glasses shall be required for presenter and student. Full-face shields shall be used, in addition to safety glasses, when pouring LN and when inserting or removing objects from LN.Do not use hand, even if gloved, to push an object into LN. Use wooden tongs, stir stick, spoon, or similar instrument to insert or remove objects from LN.
• Shattering of Flask.	<ul style="list-style-type: none">Flask shall be a Pyrex flask and should be replaced every year with new one.A door or window in the classroom shall be open when LN is in use.

Procedure:
<ul style="list-style-type: none">Don safety glasses, face shield, gloves and lab coat.Pour about 1-inch of LN into the bottom of the flask so the audience can see it boiling. Turn the flask on its edge so they can see the ice crystals forming on the container.Put the adapter and balloon on top of the flask.Observe the balloon expanding. After a significant amount has expanded the balloon, allow it to pop off and fly around the room.Discuss the reasons for this reaction.

Copper Bowl

Equipment or Chemicals:			
• LN	• Copper bowl		

Hazards:	Controls:
• Direct contact with LN.	• Loose-fitting gloves (such as leather) and safety glasses shall be required for presenter and student. Full-face shields shall be used, in addition to safety glasses, when pouring LN and when inserting or removing objects from LN. • A door or window in the classroom shall be open when LN is in use.
• Spinning of the bowl off the stand.	• Rubber cork shall be secured to the bowl.
• Splitting of the cork off the bowl.	• Copper bowl shall be secured to stand.

Procedure:
• Don safety glasses, gloves, face shield, and lab coat. • Pour about 1-inch of LN into the engineered copper bowl. • Observe the spin of the bowl resulting from energy released by change of state. • Allow LN to dissipate during the discussion.

Superconductor

Equipment or Chemicals:			
• LN	• Ceramic disk	• Tiny Magnet	• Petri dish and insulator

Hazards:	Controls:
<ul style="list-style-type: none">• Contact and spilling of LN.	<ul style="list-style-type: none">• Loose-fitting gloves (such as leather) and safety glasses shall be required for presenter and student. Full-face shields shall be used, in addition to safety glasses, when pouring LN and when inserting or removing objects from LN.• Do not use hand, even if gloved, to push an object into LN. Use wooden tongs, stir stick, spoon, or similar instrument to insert or remove objects from LN.• Students shall be a safe distance from the demonstration.• Camera and TV should be used for better viewing.• A door or window in the classroom shall be open when LN is in use.

Procedure:
<ul style="list-style-type: none">• Ensure adequate distance is maintained from the audience to the experiment.• Install camera and TV monitor.• Place the magnet and ceramic dishes in the petri dish.• Don safety glasses, face shield, and gloves.• Pour some LN in the petri dish placed in an insulating polystyrene device.• Observe the magnet floating over the superconductor.

CO₂ and He Balloons

Equipment or Chemicals:			
• 9-inch balloons	• He gas tank	• CO ₂ gas tank	

Hazards:	Controls:
• Risk of balloon bursting from gases.	• Safety glasses shall be worn by the presenter.
• Noise induced by balloon burst.	• Should warn the audience about the possible risk of loud noise.

Procedure:
<ul style="list-style-type: none">• Ensure safety glasses are worn.• Fill the balloons to the same size with different gases. Explain gas is not hazardous.• Get a student to hold both balloons and tell the audience how to find out which one of the two is the heaviest.

Airlift

Equipment or Chemicals:			
• Plastic zip-bags	• Encapsulated lead	• Piece of wood	• Piece of cloth
• Duct sealer	• Straw	• Safety click	

Hazards:	Controls:
• Hazard of contamination when blowing air in bag.	• Shall use a new straw for every demo.
• Fall of brick from table.	• Shall not let student hold the brick.
• Fall from table.	• Shall use the stool to step up on table. • Shall have an adult act as a spotter and stay close to student to prevent any fall.

Procedure:
• Assemble straw, bag, pieces of wood and cloth, and lead brick. • Blow air in bag. • Use a student to blow air in bag to raise the brick and another student later.

Marshmallows

Equipment or Chemicals:			
• Marshmallows	• Vacuum pump	• Hose	• Bell-jar

Hazards:	Controls:
• Projection from Bell-jar.	• Safety glasses should be worn by student helper and presenter.

Procedure:
<ul style="list-style-type: none">• Ask a student to make a mock marshmallow astronaut.• Put the astronaut in Bell-jar and hook it up to the vacuum pump.• Pump air out of the jar. Discuss vacuum pressure dynamics while air is pumping out of the jar.• Let air flow back inside.

Metal Can - Air Out

Equipment or Chemicals:			
• Metal can + lid	• Vacuum pump	• Top adapter	

Hazards:	Controls:
<ul style="list-style-type: none">Cuts, laceration from sharp edges.	<ul style="list-style-type: none">Gloves shall be worn by student and presenter.Shall be in control of pump at all time.Metal can shall be held by hose instead of handle on can.

Procedure:
<ul style="list-style-type: none">Don gloves.Plug the adapter to the can with pump via hose.Pump air out of can.

Metal Can – Pressure In

Equipment or Chemicals:			
• Metal can	• Lid	• Liquid Nitrogen	

Hazards:	Controls:
<ul style="list-style-type: none">Shattering of frozen can.	<ul style="list-style-type: none">Shall have no student helper.Shall take the experiment outside.Shall have the group of students 10m away from experiment.Shall point the can away from students.
<ul style="list-style-type: none">Direct contact with LN.	<ul style="list-style-type: none">Loose-fitting gloves (such as leather) and safety glasses shall be required for presenter. Full-face shield shall be used, in addition to safety glasses, when pouring LN and when inserting or removing objects from LN.Shall have the group of students at least 3 feet away from experiment.Shall <u>not</u> screw the top on the can.Shall point the can away from students.

Procedure:
<ul style="list-style-type: none">Don safety glasses, gloves, and face shield.Use the crunched metal can to get it back to shape.Pour some LN into the metal can and ensure the vessel is placed over a trash can during the demonstration.Explain that the LN creates pressure to get the can back to shape.Place the can inside a photo tray when demonstration is completed.

Pressure Plates

Equipment or Chemicals:			
• Pressure plates	• Straw	• Duct sealer	

Hazards:	Controls:
• Health contamination.	• Shall use a new straw every time.
	• Shall <u>not</u> apply mouth directly to valve.
• Fall from plates splitting up.	• Shall have 2 adults ready to catch the students if plates split apart.

Procedure:
<ul style="list-style-type: none">• Affix straw to valve and secure it with Duct seal.• Draw air between plates.• Get 4 students to pull on plates to separate them.

Hovercraft

Equipment or Chemicals:			
• Hovercraft			

Hazards:	Controls:
<ul style="list-style-type: none">Risk of student falling	<ul style="list-style-type: none">Students are never more than 6 inches above solid surface while sitting on hovercraft.Have an adult act as spotter while students are sitting on hovercraft.

Procedure:
<ul style="list-style-type: none">Have 2 students sit on the hovercraft.Provide detailed instruction to students for starting and stopping the hovercraft. Develop a signal in case a student becomes concerned and wants to stop immediately.Turn the hovercraft on and have adult act as spotter during demonstration.